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Memorandum

SRF No. 0159014

To: David Bolf, PE
Northland Consulting Engineers

From: Matt Pacyna, PE, Senior Associate
Tom Sachi, EIT, Engineer

Date: April 6, 2016

Subject: Duluth Edison High School Traffic Study

Introduction

SRF has completed a traffic study for the proposed Duluth Edison Charter High School and apartment complex located north of Rice Lake Road (CSAH 4) between Technology Drive and Krueger Road in the City of Duluth (see Figure 1: Project Location). The proposed high school will be located to the west of the existing Northstar Academy Charter School. The main objectives of this study are to review existing operations within the study area, evaluate traffic impacts to the adjacent roadway network, and recommend any necessary improvements to accommodate the proposed developments. The following sections provide the assumptions, analysis, and study conclusions/recommendations offered for consideration.

Existing Conditions

The existing conditions were reviewed to establish a baseline in order to identify any future impacts associated with the proposed development. The evaluation of existing conditions includes peak period intersection turning movement counts, field observations, and an intersection capacity analysis.

Data Collection

Peak period turning movement and pedestrian counts were collected by SRF during the week of October 5, 2015 at the following study intersections:

- CSAH 4 and Airport Road
- CSAH 4 and Airpark Boulevard
- CSAH 4 and Krueger Road
- CSAH 4 and Technology Drive
- CSAH 4 and Arlington Avenue/Arrowhead Road
- CSAH 4 and Sawyer Avenue/Arrowhead Road

In addition to the intersection turning movement counts, short-term pulse (i.e. 15-minute) counts were collected at driveways within the study area and at Persons Street in order to establish travel patterns. The traffic data focused on the a.m. (7:30 a.m. to 8:30 a.m.) and school afternoon/p.m. (4:00 p.m. to 5:00 p.m.) peak hours. It should be noted that the afternoon school and p.m. peak hour occurred at the same time, due to the current Northstar Academy Chart School hours (8:30 a.m. to 4:00 p.m.). Historical annual average daily traffic (AADT) volumes within the study area, provided by the Minnesota Department of Transportation (MnDOT), were also reviewed.

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Project Location

Duluth Edison Charter School Expansion Traffic Study
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Figure 1

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In addition to the intersection turning movement counts, observations were completed to identify roadway characteristics within the study area (i.e. roadway geometry, posted speed limits, and traffic controls). Currently, CSAH 4 is a two-lane roadway with a posted speed limit of 55 miles per hour (mph) north of Arrowhead Road and 45 mph south of Arrowhead Road. Arrowhead Road is a four-lane roadway with a posted speed limit of 40 mph. Arlington Avenue is a two-lane roadway with a posted speed limit of 40 mph.

The CSAH 4 intersections with Technology Drive, Arlington Avenue, and Sawyer Avenue are currently controlled by traffic signals. All remaining intersections within the study area are side-street stop controlled. It should be noted that the CSAH 4/Airport Road intersection has been identified as an intersection that will be upgraded to a traffic signal in the near future. CSAH 4, Arrowhead Road, and Arlington Avenue are functionally classified as minor arterial facilities, while all other study roadways are functionally classified as local streets. Existing geometrics, traffic controls, and volumes within the study area are shown in Figure 2.

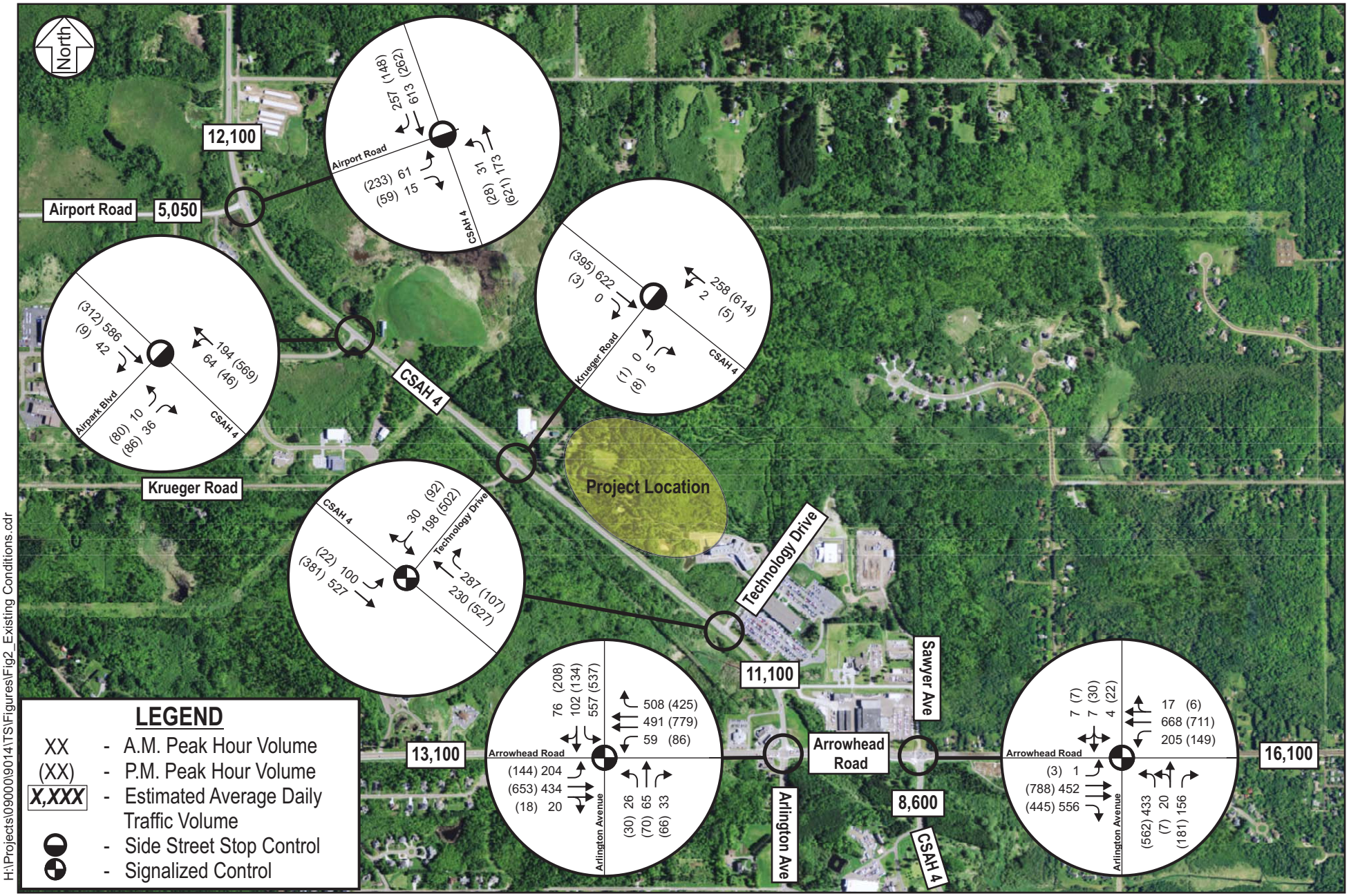
Existing Intersection Capacity Analysis

An existing intersection capacity analysis was completed using Synchro/SimTraffic software (V8.0) to establish a baseline condition to which future traffic operations could be compared. Capacity analysis results identify a Level of Service (LOS) which indicates how well an intersection is operating. Intersections are ranked from LOS A through LOS F. The LOS results are based on average delay per vehicle, which correspond to the delay threshold values shown in Table 1. LOS A indicates the best traffic operation, while LOS F indicates an intersection where demand exceeds capacity. Overall intersection LOS A though LOS C is generally considered acceptable in the Duluth area.

Table 1. Level of Service Criteria for Signalized and Unsignalized Intersections

LOS Designation	Signalized Intersection Average Delay/Vehicle (seconds)	Unsignalized Intersection Average Delay/Vehicle (seconds)
A	≤ 10	≤ 10
B	> 10 - 20	> 10 - 15
C	> 20 - 35	> 15 - 25
D	> 35 - 55	> 25 - 35
E	> 55 - 80	> 35 - 50
F	> 80	> 50

For side-street stop/yield controlled intersections, special emphasis is given to providing an estimate for the level of service of the side-street approach. Traffic operations at an unsignalized intersection with side-street stop/yield control can be described in two ways. First, consideration is given to the overall intersection level of service. This takes into account the total number of vehicles entering the intersection and the capability of the intersection to support these volumes.



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Existing Conditions

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Figure 2

Second, it is important to consider the delay on the minor approach. Since the mainline does not have to stop, the majority of delay is attributed to the side-street approaches. It is typical of intersections with higher mainline traffic volumes to experience high levels of delay (i.e. poor levels of service) on the side-street approaches, but an acceptable overall intersection level of service during peak hour conditions.

Due to the presence of the Northstar Academy Charter School, a separate analysis was completed for both the peak 15-minute interval as well as a full 60-minute interval (i.e. the peak hour). Since schools generally peak for shorter times (i.e. 15-minute intervals), the extra analysis was considered to ensure any improvements were not based solely on a 15-minute or 60-minute period of traffic.

Results of the existing intersection capacity analysis for the peak 15-minute interval shown in Table 2 indicates that the CSAH 4/Airport Road intersection operates at LOS D during the p.m. peak 15-minute period. Side-street left-turns were observed to be difficult from both Airport Road and Airpark Boulevard onto CSAH 4 during the p.m. peak 15-minute period. Additionally, southbound left-turns at the CSAH 4 and Arlington Avenue/Arrowhead Road intersection are difficult during both the a.m. and p.m. peak hours. During the a.m. peak hour, this queue was observed often extending beyond Persons Street and the right-in only turn lane into the Optum/United Health Group driveway.

Table 2. Existing Intersection Capacity Analysis – 15 Minute Interval

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road(1)	A/C	23 sec.	D/F	137 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	19 sec.	A/E	45 sec.
CSAH 4 and Krueger Road(1)	A/B	14 sec.	A/B	14 sec.
CSAH 4 and Technology Drive	B	12 sec.	C	27 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	C	33 sec.	C	28 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	20 sec.	C	26 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

Additionally, internal queuing was present for the Northstar Academy Charter School and Optum/United Health Group driveways along Technology Drive during the school start and end times. This queuing and delay is a result of the operations at the CSAH 4/Technology Drive intersection, and the driveway density and configuration along Technology Drive. The queuing and delay observed at these intersections occur primarily only in the peak 15-minute period immediately before and after school.

Based on observations, traffic volumes in the study area remain steady over the course of the peak hour at several study intersections. Therefore, a full 60-minute (i.e. peak hour) analysis was completed to confirm the observations and quantify area traffic operations.

Results of the existing intersection capacity analysis for the 60-minute peak period shown in Table 3 indicates that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours. However, the significant side-street left-turning delay for motorists on Airport Road turning left onto CSAH 4 continues throughout the entire peak hour. It should be noted that a traffic signal is planned to be installed at this intersection, which is expected to alleviate the side-street delay and queuing noted. This signal was assumed to be constructed for the future intersection capacity analysis.

Table 3. Existing Intersection Capacity Analysis – 60 Minute Interval

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road(1)	A/C	17 sec.	B/F	55 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	14 sec.	A/C	20 sec.
CSAH 4 and Krueger Road(1)	A/B	13 sec.	A/B	12 sec.
CSAH 4 and Technology Drive	B	11 sec.	C	26 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	C	29 sec.	C	28 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	17 sec.	C	26 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

Year 2020 No Build Conditions

Preliminary discussions with project stakeholders indicate several projects that are planned for the area. The majority of these are aimed at improving intersection operations, while the need for one is tied to the proposed development. The following improvements are planned to be constructed by the year 2020.

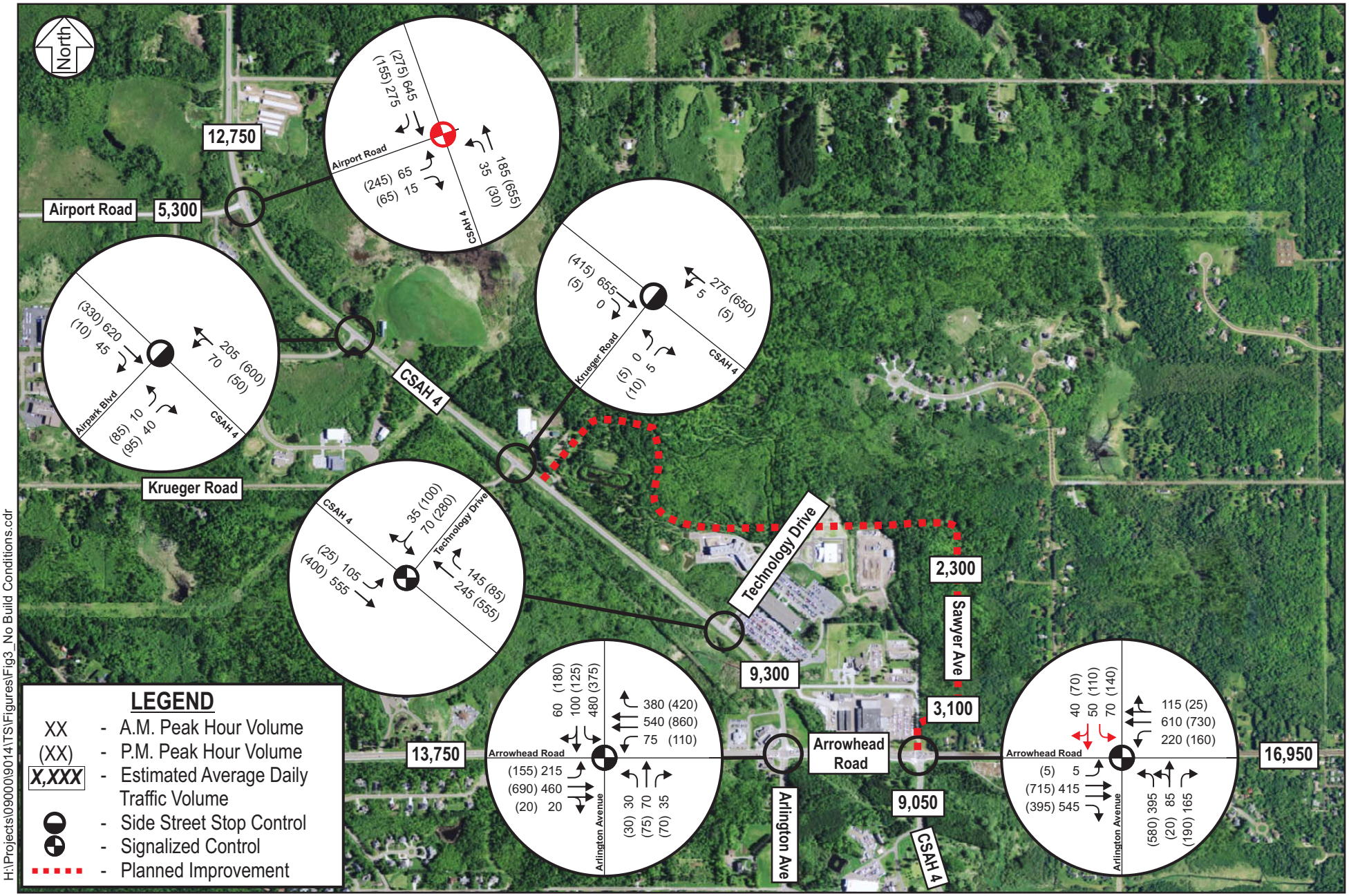
1) New traffic signal at CSAH 4 and Airport Road
2) Extension of Sawyer Avenue to Technology Drive
   a. Includes modification of the north approach of the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection to have a southbound left-turn lane and a shared thru/right-turn lane.
3) Realignment of Krueger Road to the south to align with the proposed development access.
   a. Note this realignment is only needed if the proposed development is constructed.

To determine how these planned improvements would impact area operations, a detailed intersection capacity analysis was completed. To account for area travel pattern changes due to the extension of Sawyer Avenue, existing traffic volumes collected along Technology Drive at the United Health Group and Edison School driveways were reviewed, as well as the other study area intersection turning movement counts. The driveway counts identified current travels patterns to and from Technology Drive (i.e. to/from the south or north along CSAH 4). The traffic volumes at the other study intersections were used to proportionally understand how many of the current vehicles along Technology Drive originate or are destined to either Arrowhead Road (east of CSAH 4) or CSAH 4 (south of Arrowhead Road). A portion of the users of these two routes would potentially utilize the Sawyer Avenue extension.

To determine how many of the users from these two routes would utilize the Sawyer Avenue extension, the travel time was estimated for the new routes and compared to existing travel times, which were found to be similar. Results of a route diversion analysis indicate that if there are two routes with similar travel times, there would be approximately a 50/50 split of vehicles between the two routes. Therefore, the existing traffic volumes were modified accordingly to reflect existing conditions with a Sawyer Avenue extension. These volumes were then grown at an annual growth rate of one percent to reflect year 2020 conditions, which is consistent with the *Duluth-Superior Transportation Plan*.

With the extension of Sawyer Avenue, approximately 2,300 to 3,100 vehicles per day are expected to use Sawyer Avenue under year 2020 no build conditions. The higher end of the volume range would occur closer to Arrowhead Road, while the lower end would occur closer to Technology Drive. It should be noted that no high school or apartment volumes were included as part of the no build analysis. The year 2020 no build conditions are shown in Figure 3.

Results of the year 2020 no build intersection capacity analysis for the peak 15-minute interval shown in Table 4, indicates that all intersections are expected to operate at an acceptable overall LOS C or better during the a.m. and p.m. peak 15-minute periods. The side-street delay of the Airpark Boulevard is expected to be approximately 55 seconds (LOS F) during the p.m. peak 15-minute period. The queuing issues along Technology Drive and CSAH 4 are expected to improve due to the extension of Sawyer Avenue as motorists will have an alternative route to consider.



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Year 2020 No Build Conditions

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Figure 3

Table 4. Year 2020 No Build Intersection Capacity Analysis – 15 Minute Interval

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road	A	8 sec.	B	12 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	21 sec.	B/**F**	**55 sec.**
CSAH 4 and Krueger Road(1)	A/C	15 sec.	A/B	14 sec.
CSAH 4 and Technology Drive	A	8 sec.	B	16 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	C	30 sec.	C	25 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	25 sec.	C	35 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

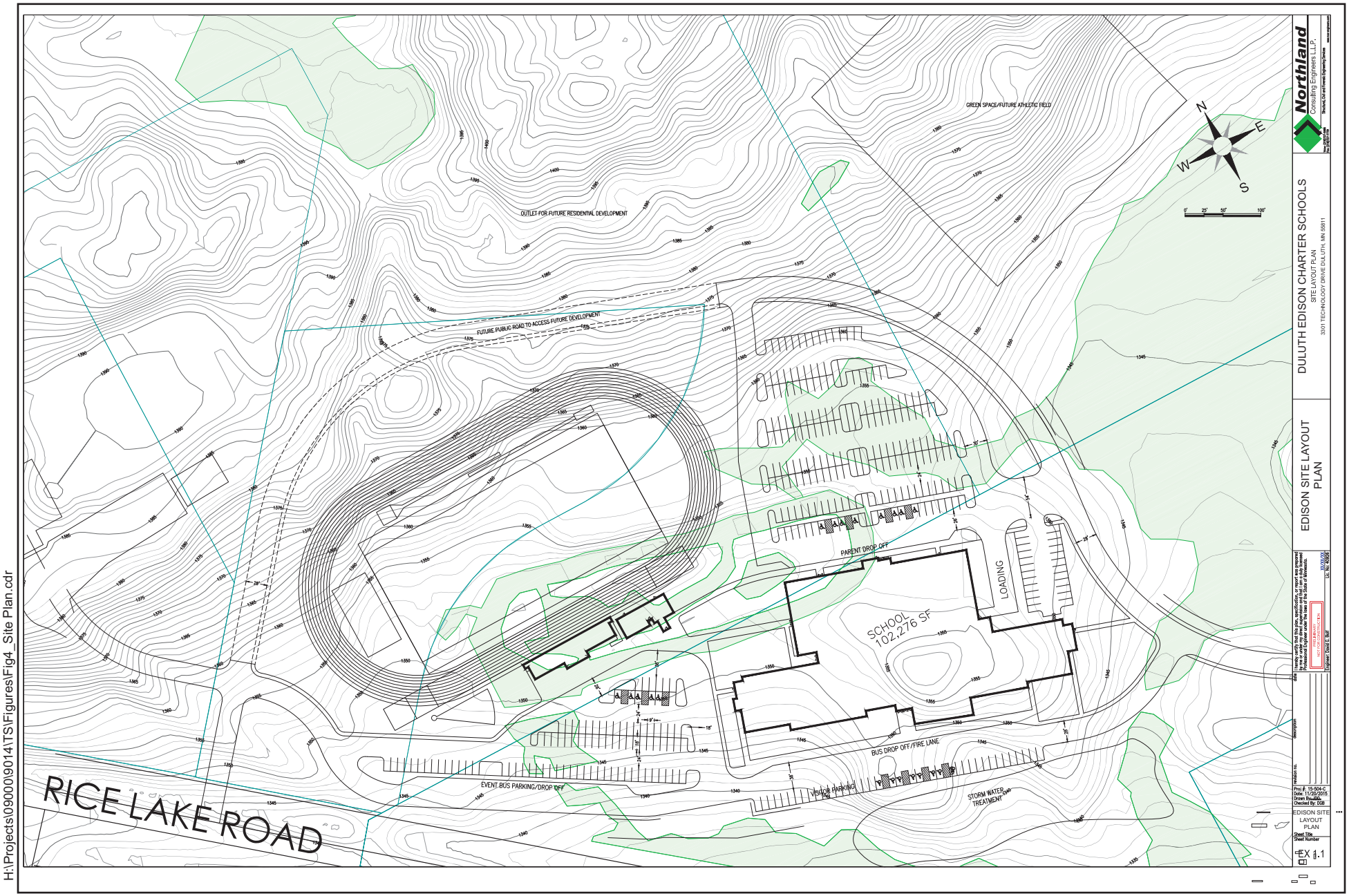
An additional intersection capacity analysis was completed to determine the impacts of the planned improvements over the course of the full 60-minute peak hour. Results of the year 2020 no build intersection capacity analysis for the 60-minute peak period shown in Table 5 indicates that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours. It should be noted that this includes the current north/south split phasing at the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection.

Table 5. No Build Intersection Capacity Analysis – 60 Minute Interval

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road	A	7 sec.	B	11 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	15 sec.	A/C	23 sec.
CSAH 4 and Krueger Road(1)	A/B	13 sec.	A/B	12 sec.
CSAH 4 and Technology Drive	A	7 sec.	B	17 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	C	27 sec.	C	26 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	25 sec.	C	34 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

With the addition of the north leg of Sawyer Avenue at CSAH 4 and the need to modify the north approach to accommodate the additional traffic volumes, there is the opportunity to remove the north/south split phasing. This would provide some signal timing flexibility for the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection. Therefore, a sensitivity test was completed to determine how the traffic signal at the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection would operate without split phasing on the north and south approaches. To remove the split phasing, a restriping of the south approach to include dual left-turn lanes and a shared thru/right-turn lane would be needed. Results indicate that during the p.m. peak hour, removing the split phasing improves overall intersection operations, while similar operations are maintained during the a.m. peak hour.



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Site Plan

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Figure 4

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Proposed Development

The proposed Edison Charter High School and apartment complex development is located along CSAH 4, west of the existing Northstar Academy Charter School (see Figure 4 – Site Plan) in the City of Duluth. Once fully completed and occupied, the proposed development is expected to consist of an 800 student charter high school and 400 apartment units. It should be noted that upon initial construction, opening is planned for the year 2017. However, full occupancy of the high school is not planned until approximately year 2020.

Access to the proposed development is planned along CSAH 4 approximately 250 feet south of Krueger Road. However, if the proposed development is approved, Krueger Road would be realigned opposite of the development access, creating a four-legged intersection. Access to the site is also planned via the new Sawyer Avenue extension from Arrowhead Road to Krueger Road.

Year 2020 Build Conditions

To help determine impacts associated with the proposed development, traffic forecasts were developed for year 2020 build conditions. Year 2020 build conditions take into account the year 2020 no build condition and traffic generated by the proposed development. The evaluation of year 2020 build conditions includes a trip generation estimate for the proposed development and an intersection capacity analysis.

Trip Generation

To account for traffic impacts associated with the proposed development, a trip generation estimate for the proposed land use was developed for the a.m. and p.m. peak hours as well as a daily basis. These estimates, shown in Table 6, were developed using the *ITE Trip Generation Manual, Ninth Edition*.

Table 6. Trip Generation Estimates

Land Use Type *(ITE Code)*	Size	A.M. Peak Hour Trips		P.M. Peak Hour Trips		Daily Trips
		In	Out	In	Out	
Proposed Land Use						
Apartments *(220)*	400 Dwelling Units	41	163	161	87	2,660
High School *(530)*	800 Students	234	110	77	155	1,368
	New System Trips	275	273	238	242	4,028

The proposed development is expected to generate approximately 548 a.m. peak hour, 480 p.m. peak hour and 4,028 daily trips. These trips were distributed throughout the area based on the directional distribution shown in Figure 5, which was developed based on existing area travel patterns and engineering judgment. It should be noted that an internal multi-use reduction was not applied for trips between the proposed apartments and high school. Since the proposed high school is expected to be a charter school, students living in the apartments are not likely to be destined to attend the school unless families enroll accordingly. Therefore to provide a conservative analysis, no multi-use internal reductions were applied. The resultant year 2020 conditions are shown in Figure 6.

Intersection Capacity Analysis

To determine how the planned roadway network will accommodate year 2020 build conditions, an intersection capacity analysis was completed using Synchro/SimTraffic software. In addition to the existing intersections, the proposed development driveway was reviewed to determine if any queuing or delay issues are expected under year 2020 build conditions. Once again, the analysis was completed for both the 15- and 60-minute time periods. The CSAH 4 and Sawyer Avenue/Arrowhead Road intersection was assumed to continue to have split phasing for the north/south approaches.

Results of the year 2020 build intersection capacity analysis shown in Table 7 indicate that the CSAH 4 and Krueger Road/High School Access intersection is expected to operate at an overall LOS D during the p.m. peak 15-minute periods. During the p.m. peak 15-minute period, significant queuing and delays at the development access are expected. Side-street/driveway access is also expected to continue to be difficult at the CSAH 4/Airpark Boulevard intersection during the p.m. peak 15-minute period. Additionally, the CSAH 4 and Arlington Avenue/Arrowhead Road intersection is expected to operate at a LOS D during the a.m. peak hour.

Table 7. Year 2020 Build Intersection Capacity Analysis – 15 Minute Interval

Intersection	A.M. Peak Hour		P.M. Peak Hour	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road	A	8 sec.	B	12 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	22 sec.	B/**F**	**76 sec.**
CSAH 4 and Krueger Road/High School Access(1)	A/D	**30 sec.**	**D/F**	**150 sec.**
CSAH 4 and Technology Drive	B	10 sec.	C	18 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	**D**	**38 sec.**	C	31 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	25 sec.	C	34 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

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Directional Distribution

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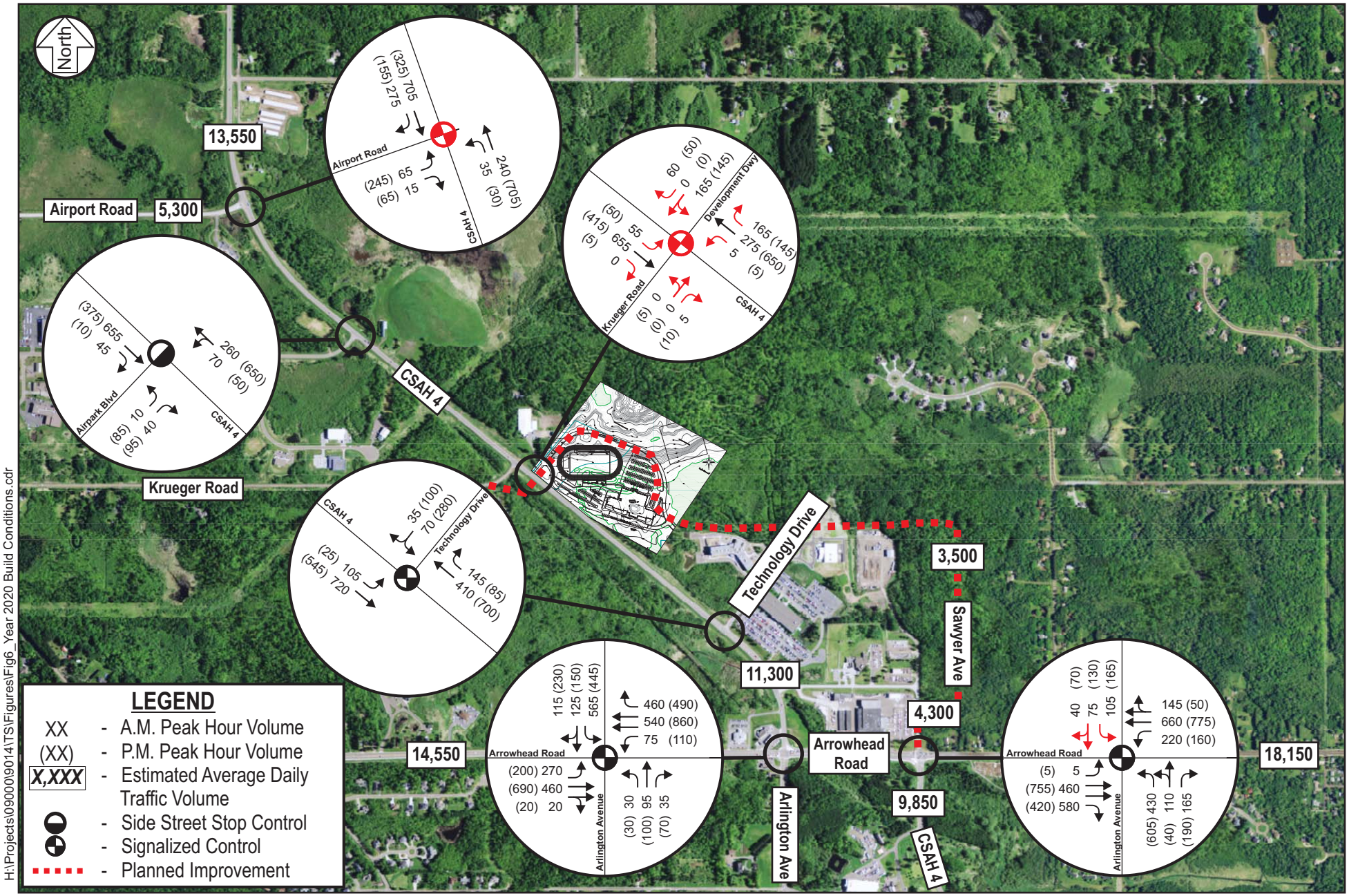
Figure 5



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Year 2020 Build Conditions

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Figure 6

Once again, a full peak hour intersection capacity analysis was completed to determine the impacts of the proposed development over the course of the full 60-minute peak hour. Results of the year 2020 build condition intersection capacity analysis for the 60-minute peak period shown in Table 8 indicate that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours. The significant side-street delay at the CSAH 4/Airpark Boulevard intersection is not expected to remain over the course of the full peak hour. However, the average side-street delay at the proposed development driveway is expected to extend over 30 seconds during the p.m. peak hour. Further discussion regarding potential mitigation is provided later in this memorandum.

Table 8. Year 2020 Build Intersection Capacity Analysis – 60 Minute Interval

Intersection	A.M. Peak		P.M. Peak	
	LOS	Delay	LOS	Delay
CSAH 4 and Airport Road	A	8 sec.	B	12 sec.
CSAH 4 and Airpark Boulevard(1)	A/C	16 sec.	A/D	27 sec.
CSAH 4 and Krueger Road/High School Access(1)	A/C	21 sec.	B/D	33 sec.
CSAH 4 and Technology Drive	A	8 sec.	B	17 sec.
CSAH 4 and Arlington Avenue/Arrowhead Road	C	31 sec.	C	31 sec.
CSAH 4 and Sawyer Avenue/Arrowhead Road	C	24 sec.	C	32 sec.

(1) Indicates an unsignalized intersection with side-street stop control, where the overall LOS is shown followed by the worst approach LOS. The delay shown represents the worst side-street approach delay.

Signal Warrant Sensitivity Tests

To address the future operational issues identified at the CSAH 4 and Krueger Road/High School Access intersection, installation of a traffic signal should be considered. However given that the proposed High School plans to phase student enrollment in over the next five years, as well as some uncertainty with the size and timing of the adjacent apartment complex, a traffic signal warrant sensitivity test was conducted to better understand the approximate timeframe/level of development when a traffic signal would meet the signal warrant criteria.

The signal warrant analysis utilized traffic volume data provided by the County as part of an ICE report conducted at the CSAH 4/Airport Road intersection in 2014. This information was modified based on the traffic data collected in 2015 as part of this study to reflect current conditions. The existing volumes along CSAH 4 were then grown at one percent annually to reflect estimated conditions for each year of the sensitivity test (2017 thru 2020).

To account for future conditions with the proposed development, hourly traffic volume and specific movement profiles were developed for the proposed High School and apartment complex based on similar land use data from www.tripgeneration.org. This volume information was added to the appropriate signal warrant scenario and a detailed analysis was completed for each condition. Results of the signal warrant sensitivity tests are summarized in Table 9. Detailed volume data and results are in the Appendix.

Table 9. Traffic Signal Warrant Matrix (CSAH 4 and Krueger Road/High School Access)

Scenario	Approximate Year and School Enrollment			
	~2017	~2018	~2019	~2020
	200 Students	400 Students	600 Students	800 Students
0 Apartments	Not Met	Not Met	Not Met	Warrant 3B
200 Apartments	Not Met	Not Met	Warrant 3B	Warrant 3B
400 Apartments	Warrant 3B	Warrant 3B	Warrant 2 and 3B	Warrant 2 and 3B

(1) Detailed signal warrant results and computations are shown in the Appendix.

Results of the signal warrant sensitivity tests indicate that there are multiple scenarios in which a traffic signal warrant is expected to be met. It is important to note that regardless of whether the apartment complex is constructed, a traffic signal warrant (Warrant 3B – Peak Hour) is expected to be met at an enrollment between 600 and 800 students. The exact timeframe in which a signal warrant will be met is dependent upon when construction is completed, market conditions, and the scale of the adjacent apartment complex. For purposes of this study, the traffic signal need occurs at some point between 2019 and 2020 conditions, assuming no apartment development.

Given some of the unknowns with respect to the current development and construction/enrollment timeframes, as well as the extension of Sawyer Avenue, a phased approach may want to be considered with respect to the installation of a traffic signal at the CSAH 4 and Krueger Road/High School access intersection. At a minimum, if/when the Krueger Road/High School access intersection is constructed, the underground traffic signal infrastructure (conduit and hand holes) should be installed. This approach would minimize future construction impacts when the decision to install a traffic signal is determined.

However it should be noted that due to the type of proposed development (i.e. High School), several young and less experienced drivers would be expected to utilize this intersection. This may warrant consideration for installing the traffic signal earlier to reduce potential conflicts and risks associated with left-turn maneuvers onto CSAH 4. Further discussion with County staff, which would make the ultimate decision regarding the installation timing of the traffic signal, and other stakeholders should occur to determine the course of action.

Recommended Improvements

To address the operational issues identified, the following improvements are offered for consideration.

CSAH 4 and Krueger Road/High School Access

1) Add southbound and northbound left- and right-turn lanes on CSAH 4.
2) Widen the Krueger Road and High School Driveway access to include right- and shared thru/left-turn lanes.
3) Coordinate with County staff and other stakeholders to determine the traffic signal installation timeframe. At a minimum, if/when the Krueger Road/High School access intersection is constructed, the underground traffic signal infrastructure (conduit and hand holes) should be installed.
    a. A traffic signal would provide acceptable overall operations (LOS B or better) during the a.m. and p.m. peak hours and improved access to CSAH 4.
    b. Given some of the unknowns with respect to the current development and construction/enrollment timeframes, as well as the extension of Sawyer Avenue, a phased approach may want to be considered with respect to the installation of a traffic signal at the CSAH 4 and Krueger Road/High School access intersection.
    c. Several young and less experienced drivers would be expected to utilize this intersection and this may warrant consideration for installing the traffic signal earlier to reduce potential conflicts and risks associated with left-turn maneuvers onto CSAH 4.
    d. Based on traffic signal spacing guidelines from MnDOT, one-quarter mile traffic signal spacing is recommended along minor arterial corridors. There is at least one-quarter mile distance between the proposed development access and both the signalized intersections along CSAH 4 at Technology Drive and Airport Road.

CSAH 4 and Arlington Avenue/Arrowhead Road

4) *Optional:* Restripe for an additional southbound left-turn.
    a. This would reduce southbound queuing and delay at the study intersection and improve overall intersection operations to a LOS C during the peak 15-minute periods.

CSAH 4 and Sawyer Avenue/Arrowhead Road

5) Construct a southbound left-turn lane.
    a) This is expected to improve intersection operations to an acceptable overall LOS C.
6) *Optional:* Remove the split timing at the north and south approaches of the intersection and replace with protected-only or flashing yellow arrow left-turn phasing.
    a) Requires the restriping of the south approach to include dual left-turn lanes and a shared thru/right-turn lane.
7) *Optional:* Construct a westbound right-turn lane to reduce conflicts between through and turning vehicles.

Note: The need for the improvements at the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection are the result of the extension of Sawyer Avenue rather than the proposed development.

Site Plan/Access Review

A review of the proposed site plans was completed to identify any issues and recommend potential improvements with regard to site access, traffic control, and circulation. Based on this review, the following issues were identified that should be discussed further and/or incorporated:

1) Internal traffic controls were not identified. However, traffic controls, signing, and striping should be incorporated based on the Manual on Uniform Traffic Control Devices (MUTCD). In particular, it is important to identify traffic controls at intersections between internal roadways/driveways to minimize vehicular conflicts and driver confusion.

It should be noted that several site plan improvements were already incorporated into the site plan as part of the development process.

Summary and Conclusions

The following study conclusions and recommendations are offered for your consideration:

1. Results of the existing intersection capacity analysis for the peak 15-minute interval indicates that the CSAH 4/Airport Road intersection operates at LOS D during the p.m. peak 15-minute period.
   a) Side-street left-turns were observed to be difficult from both Airport Road and Airpark Boulevard onto CSAH 4 during the p.m. peak 15-minute period. Southbound left-turns at the CSAH 4 and Arlington Avenue/Arrowhead Road intersection are difficult during both the a.m. and p.m. peak hours.
   b) Internal queuing was present for the Northstar Academy Charter School and Optum/United Health Group driveways along Technology Drive during the school start and end times. These operations occur primarily during the peak 15-minute period before and after school.
2. Results of the existing intersection capacity analysis for the 60-minute peak period indicates that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours.
   a) The significant side-street left-turning delay for motorists on Airport Road turning left onto CSAH 4 continues throughout the entire peak hour. A traffic signal is planned to be installed at this intersection to address this issue.
3. The following improvements are planned to be constructed by the year 2020.
   a) New traffic signal at CSAH 4 and Airport Road
   b) Extension of Sawyer Avenue to Krueger Road
   c) Realignment of Krueger Road to the south to align with the proposed development access.
      - Contingent upon construction of the proposed development.

4. Existing traffic volumes were modified to reflect year 2020 no build conditions, including an annual growth rate of one percent, which is consistent with area planning documents.
5. With the extension of Sawyer Avenue, approximately 2,300 to 3,100 vehicles per day are expected to use Sawyer Avenue under year 2020 no build conditions.
6. Results of the year 2020 no build intersection capacity analysis for the peak 15-minute interval indicates that all intersections are expected to operate at an acceptable overall LOS C or better during the a.m. and p.m. peak 15-minute periods.
    a) Side-street delay at Airpark Boulevard is expected to be approximately 55 seconds (LOS F) during the p.m. peak 15-minute period.
    b) The queuing issues along Technology Drive and CSAH 4 are expected to improve due to the extension of Sawyer Avenue as motorists will have an alternative route to consider.
7. Results of the year 2020 no build intersection capacity analysis for the 60-minute peak period indicates that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours. This includes the current north/south split phasing at the CSAH 4 and Sawyer Avenue/Arrowhead Road intersection.
    a) If split phasing were to be removed, the overall operations are improved in the p.m. peak hour and maintained during the a.m. peak hour. However, the south approach would need to be re-striped to include dual left-turn lanes and share thru/right-turn lane.
8. The proposed development is expected to consist of an 800 student charter high school and 400 apartment units. This will generate approximately 548 a.m. peak hour, 480 p.m. peak hour and 4,028 daily trips.
9. Results of the year 2020 build intersection capacity analysis indicate that the CSAH 4 and Krueger Road/High School Access intersection is expected to operate at an overall LOS D during the p.m. peak 15-minute period.
    a) Significant side-street queuing and delays over two and a half minutes are expected at the Krueger Road/High School Access.
10. Results of the year 2020 build condition intersection capacity analysis for the 60-minute peak period indicate that all study intersections currently operate at an acceptable overall LOS C or better during the a.m. and p.m. peak hours.
    a) The average side-street delay at the proposed development driveway is expected to extend over 30 seconds during the p.m. peak hour.
11. Results of the signal warrant sensitivity tests indicate that there are multiple scenarios in which a traffic signal warrant is expected to be met. The exact timeframe in which a signal warrant will be met is dependent upon when construction is completed, market conditions, and the scale of the adjacent apartment complex.

12. To address the operational issues identified, the following improvements are offered for consideration.

    a) CSAH 4 and Krueger Road/High School Access

        - Add southbound and northbound left- and right- turn lanes on CSAH 4.
        - Widen the Krueger Road/High School Driveway access to include a right- and shared thru/left-turn lanes.
        - Coordinate with County staff and other stakeholders to determine the traffic signal installation timeframe. At a minimum, if/when the Krueger Road/High School access intersection is constructed, the underground traffic signal infrastructure (conduit and hand holes) should be installed.

    b) CSAH 4 and Arlington Avenue/Arrowhead Road

        - *Optional* - Restripe to include an additional southbound left-turn.

    c) CSAH 4 and Sawyer Avenue/Arrowhead Road

        - Construct a southbound left-turn lane.
        - *Optional* - Remove the split timing at the north and south approaches of the intersection and replace with protected-only or flashing yellow arrow left-turn phasing.
            - Requires the restriping of the south approach to include dual left-turn lanes and a shared thru/right-turn lane.
        - *Optional* - Construct a westbound right-turn lane.

    d) Incorporate traffic controls, signing, and striping based on the Manual on Uniform Traffic Control Devices (MUTCD).

APPENDIX

Hourly Approach Volume Estimates

	Provided By County		Adjusted		Provided By County		Adjusted		Adjusted		Apartment Data From tripgeneration.org		School Data From tripgeneration.org	
Time	Northbound (CSAH 4)	Percent	Northbound (CSAH 4)	Percent	Southbound (CSAH 4)	Percent	Southbound (CSAH 4)	Percent	Eastbound (Krueger Road)	Percent	Base Data	Adjusted	Base Data	Adjusted
7 - 8 AM	131	1.2%	254	2.1%	504	4.7%	615	5.3%	5	3.5%	7.3%	7.8%	20.7%	25.0%
8 - 9 AM	122	1.1%	182	1.5%	309	2.9%	325	2.8%	4	2.9%	6.4%	6.5%	8.9%	8.5%
9 - 10 AM	180	1.7%	204	1.7%	230	2.1%	232	2.0%	3	2.0%	4.5%	4.5%	2.0%	2.0%
10 - 11 AM	222	2.1%	242	2.0%	233	2.2%	232	2.0%	3	2.0%	4.2%	4.0%	1.4%	1.0%
11 - 12 AM	257	2.4%	303	2.5%	270	2.5%	293	2.5%	4	2.5%	4.3%	4.3%	1.9%	1.0%
12 - 1 PM	266	2.5%	301	2.5%	244	2.3%	261	2.3%	3	2.3%	4.5%	4.5%	1.5%	1.0%
1 - 2 PM	227	2.1%	242	2.0%	219	2.0%	237	2.0%	3	2.0%	4.5%	4.5%	1.7%	1.0%
2 - 3 PM	299	2.8%	363	3.0%	222	2.1%	232	2.0%	3	2.0%	4.6%	4.5%	7.3%	5.0%
3 - 4 PM	485	4.5%	548	4.5%	258	2.4%	278	2.4%	4	2.5%	5.4%	5.5%	11.3%	8.0%
4 - 5 PM	617	5.8%	617	5.1%	311	2.9%	394	3.4%	9	6.0%	7.9%	9.3%	8.6%	17.0%
5 - 6 PM	585	5.5%	605	5.0%	250	2.3%	255	2.2%	3	2.3%	9.4%	7.8%	10.6%	10.0%
6 - 7 PM	316	3.0%	363	3.0%	167	1.6%	174	1.5%	2	1.5%	7.8%	7.5%	8.3%	7.0%
	3707	35%	4223	35%	3217	30%	3529	30%	47	31%	71%	71%	84%	87%
ADT	10700		12100		10700		11600		150					

Notes: NB/SB data provided by County from June 10, 2014.
SRF adjusted percents and ADTs to reflect 2015 conditions collected.
EB Krueger Road data estimated based on typical hourly roadway profiles and estimated ADTs based on 2015 turning movement counts.
Apartment and Middle School hourly percentages based on data from www.tripgeneration.org.
Approximately 65% of volumes along CSAH 4 occur between 7 a.m. and 7 p.m.
Approximately 70 to 75% of Apartment traffic occurs between 7 a.m. and 7 p.m.
Approximately 85 to 90% of School traffic occurs between 7 a.m. and 7 p.m.

Trip Generation Sensitivity Tests
Apartment and School Hourly Volumes

Approach Volumes (2-way)

	200 Students	400 Students	600 Students	800 Students
	Year 2017	Year 2018	Year 2019	Year 2020
7:00 AM	86	171	257	342
8:00 AM	29	58	87	116
9:00 AM	7	14	21	27
10:00 AM	3	7	10	14
11:00 AM	3	7	10	14
12:00 PM	3	7	10	14
1:00 PM	3	7	10	14
2:00 PM	17	34	51	68
3:00 PM	27	55	82	109
4:00 PM	58	116	174	233
5:00 PM	34	68	103	137
6:00 PM	24	48	72	96
7:00 PM	17	34	51	68
7 to 7 total	296	592	887	1183
% of Daily	87%	87%	87%	87%
Daily	342	684	1026	1368

	100 Apartments	200 Apartments	300 Apartments	400 Apartments
	TBD	TBD	TBD	TBD
7:00 AM	52	103	155	206
8:00 AM	43	86	130	173
9:00 AM	30	60	90	120
10:00 AM	27	53	80	106
11:00 AM	28	57	85	113
12:00 PM	30	60	90	120
1:00 PM	30	60	90	120
2:00 PM	30	60	90	120
3:00 PM	37	73	110	146
4:00 PM	62	123	185	246
5:00 PM	52	103	155	206
6:00 PM	50	100	150	200
7:00 PM	40	80	120	160
7 to 7 total	469	938	1406	1875
% of Daily	71%	71%	71%	71%
Daily	665	1330	1995	2660

Specific Movement Volumes (1-way)

	200 Students		400 Students		600 Students		800 Students	
	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left
7:00 AM	26	9	51	17	77	26	103	34
8:00 AM	9	3	17	6	26	9	35	12
9:00 AM	2	1	4	1	6	2	8	3
10:00 AM	1	0	2	1	3	1	4	1
11:00 AM	1	0	2	1	3	1	4	1
12:00 PM	1	0	2	1	3	1	4	1
1:00 PM	1	0	2	1	3	1	4	1
2:00 PM	5	2	10	3	15	5	21	7
3:00 PM	8	3	16	5	25	8	33	11
4:00 PM	17	6	35	12	52	17	70	23
5:00 PM	10	3	21	7	31	10	41	14
6:00 PM	7	2	14	5	22	7	29	10
7:00 PM	5	2	10	3	15	5	21	7
7 to 7 total	89	30	177	59	266	89	355	118
% of Daily	65%	87%	65%	87%	65%	87%	65%	87%
Daily	136.8	34.2	273.6	68.4	410.4	102.6	547.2	136.8

	100 Apartments		200 Apartments		300 Apartments		400 Apartments	
	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left	WB Left NB Right	WB Right SB Left
7:00 AM	15	5	31	10	46	15	62	21
8:00 AM	13	4	26	9	39	13	52	17
9:00 AM	9	3	18	6	27	9	36	12
10:00 AM	8	3	16	5	24	8	32	11
11:00 AM	8	3	17	6	25	8	34	11
12:00 PM	9	3	18	6	27	9	36	12
1:00 PM	9	3	18	6	27	9	36	12
2:00 PM	9	3	18	6	27	9	36	12
3:00 PM	11	4	22	7	33	11	44	15
4:00 PM	18	6	37	12	55	18	74	25
5:00 PM	15	5	31	10	46	15	62	21
6:00 PM	15	5	30	10	45	15	60	20
7:00 PM	12	4	24	8	36	12	48	16
7 to 7 total	141	47	281	94	422	141	563	188
% of Daily	53%	71%	53%	71%	53%	71%	53%	71%
Daily	266	66.5	532	133	798	199.5	1064	266

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2017 (200 Students and 0 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	285	636	921	X	X	26	5	26							X	
8 - 9 AM	194	334	528	X		9	4	9							X	
9 - 10 AM	210	237	447	X		2	3	3							X	
10 - 11 AM	248	237	485	X		1	3	3							X	
11 - 12 AM	310	299	609	X		1	4	4							X	
12 - 1 PM	308	267	575	X		1	3	3							X	
1 - 2 PM	248	243	491	X		1	3	3							X	
2 - 3 PM	375	238	613	X		5	3	5							X	
3 - 4 PM	568	287	855	X	X	8	4	8							X	
4 - 5 PM	647	408	1055	X	X	17	9	17							X	
5 - 6 PM	627	264	891	X	X	10	3	10							X	
6 - 7 PM	377	180	557	X		7	2	7							X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	0	0	0	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	0	8	Not Met
Warrant 1C:	Combination of Warrants	0	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	0	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2017 (200 Students and 200 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	316	646	962	X	X	57	5	57		X		X		X	X	
8 - 9 AM	220	343	563	X		35	4	35							X	
9 - 10 AM	228	243	471	X		20	3	20							X	
10 - 11 AM	264	242	506	X		17	3	17							X	
11 - 12 AM	327	305	632	X	X	18	4	18							X	
12 - 1 PM	326	273	599	X		19	3	19							X	
1 - 2 PM	266	249	515	X		19	3	19							X	
2 - 3 PM	393	244	637	X	X	23	3	23							X	
3 - 4 PM	590	294	884	X	X	30	4	30							X	
4 - 5 PM	684	420	1104	X	X	54	9	54		X		X		X	X	
5 - 6 PM	658	274	932	X	X	41	3	41							X	
6 - 7 PM	407	190	597	X		37	2	37							X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	2	0	2	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	2	8	Not Met
Warrant 1C:	Combination of Warrants	0	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	0	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2017 (200 Students and 400 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	347	656	1003	X	X	87	5	87		X		X	X	X	X	
8 - 9 AM	246	352	598	X		61	4	61		X				X	X	
9 - 10 AM	246	249	495	X		38	3	38							X	
10 - 11 AM	280	248	528	X		33	3	33							X	
11 - 12 AM	344	310	654	X	X	35	4	35							X	
12 - 1 PM	344	279	623	X		37	3	37							X	
1 - 2 PM	284	255	539	X		37	3	37							X	
2 - 3 PM	411	250	661	X	X	41	3	41							X	
3 - 4 PM	612	301	913	X	X	52	4	52						X	X	
4 - 5 PM	721	433	1154	X	X	91	9	91		X		X	X	X	X	
5 - 6 PM	689	284	973	X	X	72	3	72		X		X		X	X	
6 - 7 PM	437	200	637	X	X	67	2	67		X		X		X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	4	2	6	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	4	8	Not Met
Warrant 1C:	Combination of Warrants	2	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	3	4	Not Met
Warrant 3B:	Peak Hour	1	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2018 (400 Students and 0 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	313	651	964	X	X	51	5	51						X	X	
8 - 9 AM	204	340	544	X		17	4	17							X	
9 - 10 AM	214	240	454	X		4	3	4							X	
10 - 11 AM	251	240	491	X		2	3	3							X	
11 - 12 AM	314	302	616	X		2	4	4							X	
12 - 1 PM	312	270	582	X		2	3	3							X	
1 - 2 PM	251	245	496	X		2	3	3							X	
2 - 3 PM	384	242	626	X		10	3	10							X	
3 - 4 PM	581	292	873	X	X	16	4	16							X	
4 - 5 PM	671	418	1089	X	X	35	9	35							X	
5 - 6 PM	644	270	914	X	X	21	3	21							X	
6 - 7 PM	388	184	572	X		14	2	14							X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	0	0	1	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	0	8	Not Met
Warrant 1C:	Combination of Warrants	0	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	0	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2018 (400 Students and 200 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes	30	1		

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	344	661	1005	X	X	82	5	82		X		X		X	X	
8 - 9 AM	230	349	579	X		43	4	43						X	X	
9 - 10 AM	232	246	478	X		22	3	22							X	
10 - 11 AM	267	245	512	X		18	3	18							X	
11 - 12 AM	331	308	639	X	X	19	4	19							X	
12 - 1 PM	330	276	606	X		20	3	20							X	
1 - 2 PM	269	251	520	X		20	3	20							X	
2 - 3 PM	402	248	650	X	X	28	3	28							X	
3 - 4 PM	603	300	903	X	X	38	4	38							X	
4 - 5 PM	708	430	1138	X	X	72	9	72		X		X		X	X	
5 - 6 PM	675	280	955	X	X	51	3	51						X	X	
6 - 7 PM	418	194	612	X		44	2	44						X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	2	0	5	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	2	8	Not Met
Warrant 1C:	Combination of Warrants	0	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	2	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2018 (400 Students and 400 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	375	671	1046	X	X	113	5	113	X	X	X	X	X	X	X	
8 - 9 AM	256	358	614	X		69	4	69		X				X	X	
9 - 10 AM	250	252	502	X		40	3	40							X	
10 - 11 AM	283	250	533	X		34	3	34							X	
11 - 12 AM	348	314	662	X	X	36	4	36							X	
12 - 1 PM	348	282	630	X	X	38	3	38							X	
1 - 2 PM	287	257	544	X		38	3	38							X	
2 - 3 PM	420	254	674	X	X	46	3	46						X	X	
3 - 4 PM	625	307	932	X	X	60	4	60		X		X		X	X	
4 - 5 PM	744	443	1187	X	X	109	9	109	X	X	X	X	X	X	X	
5 - 6 PM	706	290	996	X	X	82	3	82		X		X		X	X	
6 - 7 PM	448	204	652	X	X	74	2	74		X		X		X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											2	5	2	7	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	2	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	5	8	Not Met
Warrant 1C:	Combination of Warrants	2	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	3	4	Not Met
Warrant 3B:	Peak Hour	2	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2019 (600 Students and 0 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	341	665	1006	X	X	77	5	77		X		X		X	X	
8 - 9 AM	215	347	562	X		26	4	26							X	
9 - 10 AM	218	243	461	X		6	3	6							X	
10 - 11 AM	255	242	497	X		3	3	3							X	
11 - 12 AM	318	306	624	X		3	4	4							X	
12 - 1 PM	316	273	589	X		3	3	3							X	
1 - 2 PM	255	248	503	X		3	3	3							X	
2 - 3 PM	393	247	640	X	X	15	3	15							X	
3 - 4 PM	595	298	893	X	X	25	4	25							X	
4 - 5 PM	694	428	1122	X	X	52	9	52						X	X	
5 - 6 PM	660	276	936	X	X	31	3	31							X	
6 - 7 PM	399	188	587	X		22	2	22							X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	1	0	2	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	1	8	Not Met
Warrant 1C:	Combination of Warrants	0	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	1	4	Not Met
Warrant 3B:	Peak Hour	0	1	Not Met
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2019 (600 Students and 200 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	372	676	1048	X	X	108	5	108	X	X	X	X	X	X	X	
8 - 9 AM	241	355	596	X		52	4	52						X	X	
9 - 10 AM	236	249	485	X		24	3	24							X	
10 - 11 AM	271	248	519	X		19	3	19							X	
11 - 12 AM	335	311	646	X	X	20	4	20							X	
12 - 1 PM	334	279	613	X		21	3	21							X	
1 - 2 PM	273	254	527	X		21	3	21							X	
2 - 3 PM	411	253	664	X	X	33	3	33							X	
3 - 4 PM	617	305	922	X	X	47	4	47						X	X	
4 - 5 PM	731	440	1171	X	X	89	9	89		X		X	X	X	X	
5 - 6 PM	691	286	977	X	X	62	3	62		X		X		X	X	
6 - 7 PM	429	198	627	X		51	2	51						X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											1	3	2	6	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	1	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	3	8	Not Met
Warrant 1C:	Combination of Warrants	2	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	3	4	Not Met
Warrant 3B:	Peak Hour	2	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2019 (600 Students and 400 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	403	686	1089	X	X	139	5	139	X	X	X	X	X	X	X	X
8 - 9 AM	267	364	631	X	X	78	4	78		X		X		X	X	
9 - 10 AM	254	255	509	X		42	3	42						X	X	
10 - 11 AM	287	253	540	X		35	3	35							X	
11 - 12 AM	352	317	669	X	X	37	4	37							X	
12 - 1 PM	352	285	637	X	X	39	3	39							X	
1 - 2 PM	291	260	551	X		39	3	39							X	
2 - 3 PM	429	259	688	X	X	51	3	51						X	X	
3 - 4 PM	639	313	952	X	X	69	4	69		X		X		X	X	
4 - 5 PM	768	452	1220	X	X	126	9	126	X	X	X	X	X	X	X	
5 - 6 PM	722	296	1018	X	X	93	3	93		X		X	X	X	X	
6 - 7 PM	459	208	667	X	X	81	2	81		X		X		X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											2	6	3	8	1	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	2	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	6	8	Not Met
Warrant 1C:	Combination of Warrants	3	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	4	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	2	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	1	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2020 (800 Students and 0 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	370	680	1050	X	X	103	5	103		X		X	X	X	X	
8 - 9 AM	226	353	579	X		35	4	35							X	
9 - 10 AM	222	247	469	X		8	3	8							X	
10 - 11 AM	258	245	503	X		4	3	4							X	
11 - 12 AM	322	309	631	X	X	4	4	4							X	
12 - 1 PM	320	276	596	X		4	3	4							X	
1 - 2 PM	258	251	509	X		4	3	4							X	
2 - 3 PM	402	251	653	X	X	21	3	21							X	
3 - 4 PM	609	304	913	X	X	33	4	33							X	
4 - 5 PM	718	438	1156	X	X	70	9	70		X		X		X	X	
5 - 6 PM	677	282	959	X	X	41	3	41							X	
6 - 7 PM	410	192	602	X		29	2	29							X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											0	2	1	2	0	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	0	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	2	8	Not Met
Warrant 1C:	Combination of Warrants	1	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	2	4	Not Met
Warrant 3B:	Peak Hour	1	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	0	8	Not Met

Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2020 (800 Students and 200 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
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Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
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Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	401	691	1092	X	X	134	5	134	X	X	X	X	X	X	X	
8 - 9 AM	252	362	614	X		61	4	61		X				X	X	
9 - 10 AM	240	253	493	X		26	3	26							X	
10 - 11 AM	274	251	525	X		20	3	20							X	
11 - 12 AM	339	315	654	X	X	21	4	21							X	
12 - 1 PM	338	282	620	X		22	3	22							X	
1 - 2 PM	276	257	533	X		22	3	22							X	
2 - 3 PM	420	257	677	X	X	38	3	38							X	
3 - 4 PM	631	311	942	X	X	55	4	55		X		X		X	X	
4 - 5 PM	755	450	1205	X	X	107	9	107	X	X	X	X	X	X	X	
5 - 6 PM	708	292	1000	X	X	72	3	72		X		X		X	X	
6 - 7 PM	440	202	642	X	X	59	2	59		X		X		X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											2	5	2	6	0	

Warrant Summary

Warrant and Description	Hours Met	Hours Required	Met/Not Met
Warrant 1A: Minimum Vehicular Volume	2	8	Not Met
Warrant 1B: Interruption of Continuous Traffic	5	8	Not Met
Warrant 1C: Combination of Warrants	2	8	Not Met
Warrant 2: Four-Hour Vehicular Volume	3	4	Not Met
Warrant 3B: Peak Hour	2	1	Met - Warrant 3B Satisfied
MWSA (C): Multiway Stop Applications Condition C	0	8	Not Met

SRF Consulting Group, Inc.

WARRANTS ANALYSIS

Year 2020 (800 Students and 400 Apartments) Excludes Westbound Right-Turns

CSAH 4 and Krueger Road/Proposed High School Access
Edison School Traffic Study
City of Duluth

Background Information

		Speed (mph)	Lanes	Approach	
Location :	City of Duluth	55	2 or more	Major Approach 1:	Northbound CSAH 4
Date:	4/5/2016	55	2 or more	Major Approach 3:	Southbound CSAH 4
Analysis Prepared By:	Tom Sachi	30	1	Minor Approach 2:	Westbound Proposed High School Access
Population Less than 10,000:	No	30	1	Minor Approach 4:	Eastbound Krueger Road
Seventy Percent Factor Used:	Yes				

Warrants Analysis: Warrants 1A, 1B and 1C

Hour	Major Approach 1	Major Approach 3	Total 1 + 3	Warrant Met 420	Warrant Met 630	Minor Approach 2	Minor Approach 4	Largest Minor App.	Warrant Met 105	Warrant Met 53	Met Same Hours Condition A	Met Same Hours Condition B	Combination A	Combination B	MWSA (C) 210	MWSA (C) 140
6 - 7 AM	0	0	0			0	0	0								
7 - 8 AM	432	701	1133	X	X	164	5	164	X	X	X	X	X	X	X	X
8 - 9 AM	278	370	648	X	X	87	4	87		X		X	X	X	X	
9 - 10 AM	258	259	517	X		44	3	44						X	X	
10 - 11 AM	290	256	546	X		36	3	36							X	
11 - 12 AM	356	320	676	X	X	38	4	38							X	
12 - 1 PM	356	288	644	X	X	40	3	40							X	
1 - 2 PM	294	263	557	X		40	3	40							X	
2 - 3 PM	438	263	701	X	X	56	3	56		X		X		X	X	
3 - 4 PM	653	318	971	X	X	77	4	77		X		X		X	X	
4 - 5 PM	792	462	1254	X	X	144	9	144	X	X	X	X	X	X	X	X
5 - 6 PM	739	303	1042	X	X	103	3	103		X		X	X	X	X	
6 - 7 PM	470	212	682	X	X	89	2	89		X		X	X	X	X	
7 - 8 PM	0	0	0			0	0	0								
8 - 9 PM	0	0	0			0	0	0								
9 - 10 PM	0	0	0			0	0	0								
10 - 11 PM	0	0	0			0	0	0								
											2	7	5	8	2	

Warrant Summary

Warrant and Description		Hours Met	Hours Required	Met/Not Met
Warrant 1A:	Minimum Vehicular Volume	2	8	Not Met
Warrant 1B:	Interruption of Continuous Traffic	7	8	Not Met
Warrant 1C:	Combination of Warrants	5	8	Not Met
Warrant 2:	Four-Hour Vehicular Volume	4	4	Met - Warrant 2 Satisfied
Warrant 3B:	Peak Hour	3	1	Met - Warrant 3B Satisfied
MWSA (C):	Multiway Stop Applications Condition C	2	8	Not Met